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HABITAT PREFERENCES, BREEDING SUCCESS, AND DIET OF THE BARN OWL (*TYTO ALBA*) IN ROME: URBAN VERSUS RURAL TERRITORIES

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Population density of the Barn Owl (*Tyto alba*) is dependent on available supply of small rodents in both the territory and home range (e.g., De Bruijn 1994, Taylor 1994). Moreover, habitat and nest quality are decisive factors in determining distribution, breeding success, and feeding habits of Barn Owls (De Bruijn 1994, Taylor 1994, Poprack 1996, Martinez and López 1999, Zuberogoitia 2000, Baudvin and Jouaire 2001). The decrease in numbers of this owl in central Europe is probably related to the development of new agricultural practices and loss of traditional nest sites (De Bruijn 1994). In Mediterranean Europe, owl populations seem to be more stable, likely due to a milder climate and large supply of prey (Martinez and López 1999, Zuberogoitia 2000), but further information is needed.

Barn Owls commonly breed in urban areas that provide suitable nest sites (e.g., Baudvin and Jouaire 2001). The ecology of the Barn Owl is poorly known in urban habitats and no direct comparisons with neighboring habitats are available. Here, we compare data on distribution, territory characteristics, habitat preferences, breeding success, and feeding habits of Barn Owls from urban and rural areas in central Italy. Understanding

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habitat preferences of this species of special concern in relation to population parameters and feeding habits may provide useful management information for a variety of habitats, including rural and urban areas.

METHODS

The study was carried out in Rome, Italy (41°53′N, 12°28′E) from spring 1995–summer 2001; urban areas included small gardens with *Pinus pinea, Cupressus sempervirens, Cedrus* sp., and *Quercus* spp. Rural areas included open lands with grassy pastures, uncultivated fields, and small forest patches, mainly of *Q. ilex* and *Q. suber* (Ranazzi et al. 2000).

We surveyed five census plots distributed along the urban gradient that included the main habitats in the study region. Nest sites and daytime roosting sites were searched for the presence of Barn Owls. Pellets, feathers, and droppings near possible nests were considered evidence for the occupation of a site. Records of territorial screeches and calls of young were collected systematically during the entire study period and were combined with the other data to locate nests. Spacing among occupied nests was calculated for each plot by the nearest-neighbor method using data from 1997 breeding season. Regularity in nest spacing was computed for each area with the *G*-test (Ranazzi et al. 2000).

We measured percentages of (1) open lands, (2) deciduous woods, (3) conifer woods, (4) urban gardens, (5) developed areas (buildings and homes), (6) Roman ruins, and (7) waterbodies in a circular plot with a radius of 1.5 km centered in the nest site (Michelat and Giraudoux 1991) at 10 urban and 7 rural Barn Owl nests whose occupation was confirmed throughout the study period. The same variables were measured in 15 unoccupied sites randomly selected along the urban gradient in the five plots surveyed. We compare each variable measured at urban and rural territories and at occupied and random sites by Mann-Whitney *U*-tests. A sequential Bonferroni test was used to adjust the significance level to the number of comparisons using the same data set ($N = 7$).

No data on clutch size were collected to minimize disturbance of the adult owls. Moreover, many nests located in scaffolding holes of old buildings were inaccessible for inspection of eggs. Visits to nests were limited to a period when young were ca. 3–6 wk of age (De Bruijn 1994).

We studied diet by analyzing pellets collected (April–August) in 15 stable territories classified as urban or rural based on the percentage of developed areas (urban: >50% developed in the circular plot with a radius of 1.5 km centered in the nest site). Prey remains were identified using diagnostic keys and by comparison with museum specimens (e.g., Piattella et al. 1999). Differences in diet composition between urban and rural diets were tested using a χ^2 contingency table which included all the prey groups reported in Table 1. We used distance of each pellet site to the center of the city (Ranazzi et al. 2000) as a relative index of the proportion of urban areas around owl sites. Spearman rank correlations were performed between the percentage of each prey group (Table 1) and the distance to the city center.

Table 1. Percent of prey types recorded in the prey remains at Barn Owl nest and roost sites in urban areas of Rome, central Italy.

	URBAN SITES $N = 7$	RURAL SITES $N = 8$
Invertebrates	0.69	1.18
Anura	0.00	0.05
Reptilia	0.13	0.00
Columbidae	0.25	0.10
Sturnus vulgaris	1.01	0.00
Passer spp.	4.53	0.88
Fringillidae	0.94	0.25
Other Passeriformes	2.96	1.97
AVES total	9.69	3.19
Suncus estruscus	1.89	3.14
Crocidura spp.	2.14	3.98
Talpa sp.	0.00	0.15
INSECTIVORA total	4.03	7.27
Chiroptera	1.01	1.77
Muscardinus avellanarius	0.00	3.34
Microtus savii	59.18	41.52
Apodemus spp.	5.72	22.36
Rattus spp.	2.83	1.23
Mus domesticus	16.67	15.23
Other mammalia	0.06	2.85
RODENTIA total	84.47	86.54
Total prey (N)	1590	2035

RESULTS

Based on the distribution of 31 Barn Owl territories, density was generally higher than those recorded in central Europe (Table 2). Mean nest spacing ranged from 1.8 km–3.0 km. The *G*-test (0.78) indicated a substantial regularity in nest distribution. Mean density in the subareas surveyed ranged from 8–21 territories/km^2.

Open lands contributed half the available area of the census plots in rural territories; this decreased in urban territories. Wooded and developed areas made up the remaining part of rural and urban territories, respectively (Fig. 1). The percentages of both deciduous and conifer woods, as well as of urban gardens showed significant differences between urban and rural territories (deciduous woods: $U = 0$, $P = 0.0006$; conifer woods: $U = 0$, $P < 0.001$; urban gardens: $U = 6.5$, $P = 0.005$). Occupied territories contained a significantly higher proportion of open lands than random plots (Table 3), but a lower proportion of vegetable gardens and developed areas.

Out of 14 breeding attempts, 2 failed (14.3%), 1 produced one fledgling (6.7%), 7 produced two fledglings (50.0%), 3 produced three fledglings (14.3%), and 1 produced four fledglings (6.7%). The mean number of

Table 2. Breeding density of Barn Owls from selected European studies.

STUDY REGION	CENSUS PERIOD	CENSUS AREA (km^2)	MEAN DENSITY (TERRITORIES/ 100 km^2)	SOURCE
Poland, Krakow	1991–95	6289	0.8	Bartmanska et al. 2000
Czech Rep., Olomouc	1983–95	1451	1.3	Poprack 1996
South Poland	1984–88	1640	1.4	De Bruijn 1994
West Germany	1960–72	841	1.7	De Bruijn 1994
Netherlands, Liemers	1967–84	250	2.4	De Bruijn 1994
Southwest Scotland	1981–85	2200	3.2	De Bruijn 1994
East Germany	1968–74	1000	3.3	De Bruijn 1994
Netherlands, Achterhoek	1967–84	250	5.3	De Bruijn 1994
Germany, Bergenhusen	1974–79	100	10.0	De Bruijn 1994
Italy, Rome	1995–2001	241	12.8	This study

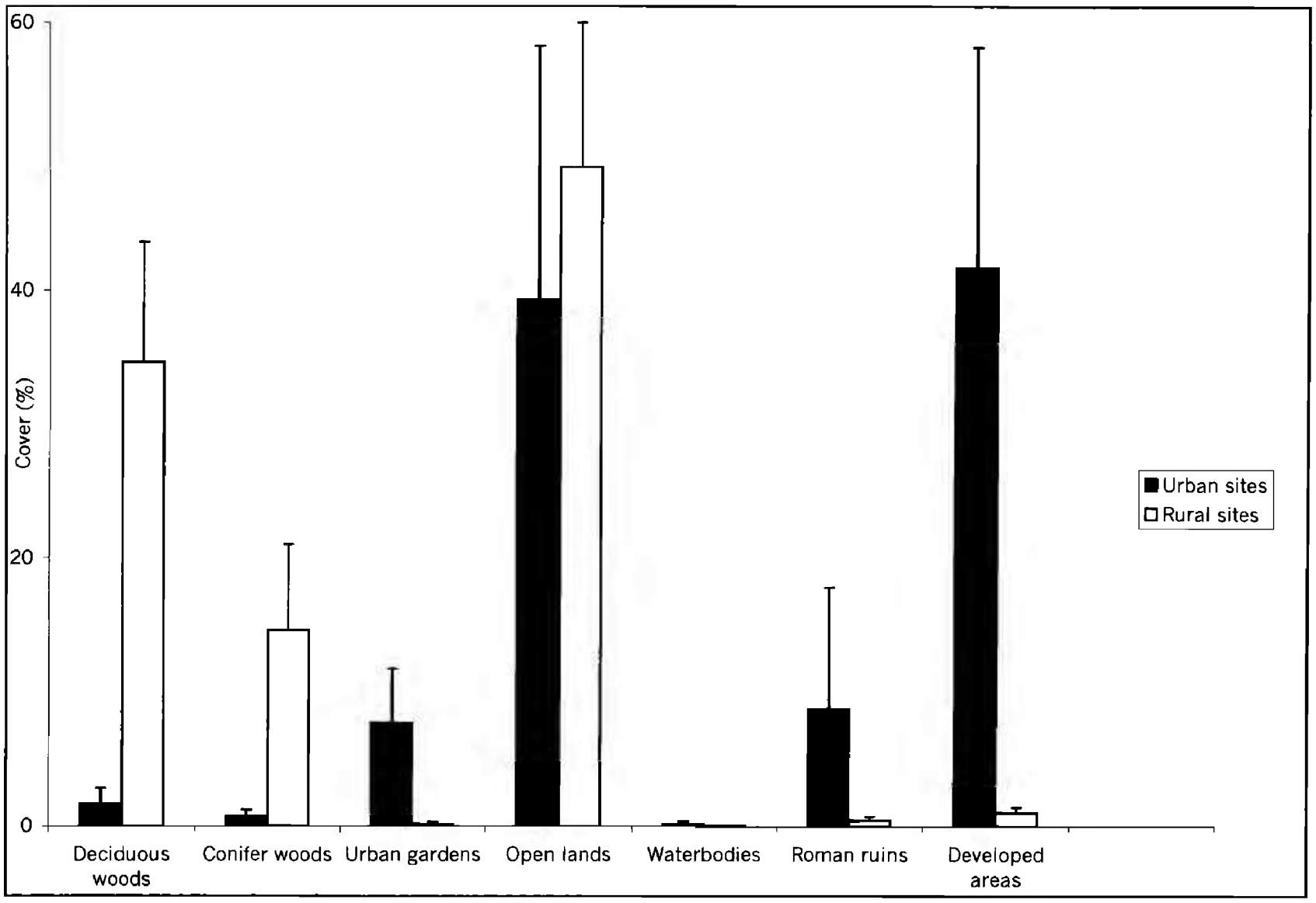

Figure 1. Percentage of different habitat cover types found within a 1.5 km diameter plot centered on Barn Owl nests in urban ($N = 10$) and rural ($N = 7$) areas in Rome. Error bars represent the SD around the mean percentage of each land cover variable.

Table 3. Percentages of seven land cover variables (mean ± SD) in seventeen occupied territories and fifteen random sites in Rome, central Italy.

VARIABLE	OCCUPIED TERRITORIES	RANDOM SITES	*P*-LEVEL
Deciduous woods	15.2 ± 20.1	1.5 ± 2.3	0.02
Conifer woods	6.5 ± 10.6	0.7 ± 1.3	0.02
Urban gardens	4.6 ± 7.1	15.9 ± 8.8	0.001*
Open lands	43.4 ± 32.1	2.0 ± 2.4	<0.0001*
Waterbodies	0.1 ± 0.3	1.3 ± 3.5	0.83
Roman ruins	5.3 ± 14.3	1.2 ± 2.1	0.35
Developed areas	25.0 ± 32.2	77.5 ± 11.1	0.0001*

* $P < 0.05$ based on Mann-Whitney *U*-test after Bonferroni correction—see methods for details.

fledglings was 2.0 (SD = 1.2) per breeding pair and was low compared to data collected in central Europe (Table 4). Urban owls reared more fledglings than rural ones (2.3 vs. 1.7 fledglings per breeding pair, $N = 7$ breeding attempts per each habitat), but this difference was not significant ($U = 10$, $P = 0.20$).

Based on 3625 prey analyzed, rodents (Rodentia) and shrews (Insectivora) represented 94% of total prey in Barn Owl diets from rural sites and 88% in urban sites (Table 1). Birds, especially sparrows, increased in urban areas. Differences in diet composition between urban and rural sites were significant ($\chi^2 = 436.74$, $P < 0.001$, df = 17). The percent numbers of *Crocidura* shrews ($r_s = 0.58$, $P = 0.02$, $N = 15$), *Muscardinus* dormices ($r_s = 0.52$, $P = 0.05$, $N = 15$), and *Apodemus* mice ($r_s = 0.64$, $P = 0.01$, $N = 15$) increased with the distance to the city center. The percent numbers of both *Microtus* voles ($r_s = -0.66$, $P = 0.007$, $N = 15$) and rats ($r_s = -0.73$, $P = 0.002$, $N = 15$) strongly decreased with the distance to the city center.

DISCUSSION

The close nest spacing in our study area is probably due to high availability of nest sites (De Bruijn 1994, Baudvin and Jouaire 2001). In urban areas, ruins, towers, and old farmhouses provided a surplus of nest cavities. Barn Owls primarily defend their nest sites rather than a breeding territory around them; thus, feeding areas overlap extensively and are dynamic depending on nest supply and prey densities (Taylor 1994). Stable weather typical of the Mediterranean basin may further account for high population levels in Rome, compared to more forested rural areas. In both urban and rural sites, open lands represented the primary foraging habitat found within Barn Owl nesting areas (De Bruijn 1994) and the proportion of open habitats was significantly less at random sites (Table 3). Ruins and gardens were abundant in urban territories providing more foraging areas for owls at these sites compared with rural areas.

The breeding success, although based on a limited sample, was lower than those recorded in central Europe The abundance of rodents has been reported to strongly influence the reproduction of Barn Owls (Taylor 1994) Owls in areas with generally drier climates probably have lower prey densities (e.g., Herrera and Hiraldo 1976) compared to populations from central Europe, and a reduction in the availability of rodents seems plausible to explain the low breeding rate in Rome. The switch to-

Table 4. Breeding success of Barn Owls from selected European study areas.

STUDY REGION	DURATION OF STUDY (YEARS)	MEAN FLEDGLINGS PER PAIR	SOURCE
Czech Rep., Olomouc	12	5.0	Poprack 1996
Slovakia	4	4.5	Sarossy 2000
East Germany	7	4.3	Taylor 1994
France, Burgundy	25	4.0	Baudvin and Jouaire 2001
Germany, Saarland	5	3.9	Poprack 1996
Southwest Scotland	13	3.2	Taylor 1994
Holland	6	3.1	De Bruijn 1994
Spain, Vizcaya	6	2.2	Zubergoitia 2000
Italy, Rome	5	2.0	This study

ward synantropic rodents and birds in the diet at urban sites reflects the reduction of prey diversity that occurs in such areas and indicates the variation in the availability of small mammal species along the urban gradient (Piattella et al. 1999). The predation on abundant rat populations may explain locally high breeding success in urban areas compared to neighboring farmlands (Martinez and López 1999).

RESUMEN.—Recolectamos datos (1995–2001) sobre la distribución, características del territorio, preferencias de hábitats, tasas de reproducción y hábitos alimenticios de la lechuza de campanario (*Tyto alba),* en reproducción en zonas rurales y urbanas de Roma, Italia. La distancia entre nidos osciló entre 1.8 km. A 3.0 km. Los territorios urbanos incluyeron más espacio abierto que los rurales. Los territorios de las lechuzas contenían un mayor porcentaje de áreas boscozas (21.7%) que los sitios escogidos al azar (2.2%). El número medio de volantones producidos por pareja en reproducción (2.0 ± 1.2) fue inferior a aquellos registrados para el centro de Europa. Los roedores representaron el 94% de las presas en áreas rurales, pero solo el 88% en sitios urbanos. Los roedores del genero *Microtus* y las ratas, dominaron la dieta de los sitios urbanos, mientras que los del genero *Apodemus* y *Muscardinus* fueron depredados en sitios rurales. Un clima estable y el aprovisionamiento de nidos, probablemente contribuyeron a los altos niveles de población en Roma. Una reducción general de pequeños mamíferos en las áreas secas del Mediterráneo puede explicar el bajo éxito reproductivo comparado con las poblaciones del centro de Europa.

[Traducción de César Márquez]

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